The Electromyographic Activity of Thoracic Paraspinal Muscles Identified as Abnormal With Palpation

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Abstract

Objective: The aim of this study was to compare the electromyographic (EMG) activity of deep muscles in the thoracic paravertebral gutter (PVG) detected as abnormal to palpation (AbPT) and reported as tender by the subject with muscles underlying nontender (NT), normal to palpation sites under various experimental conditions.

Methods: Twelve subjects (mean age, 25.42 years; range, 22-43 years) participated in this study. Fine-wire, bipolar intramuscular electrodes were inserted, under real-time ultrasonic guidance, into the deep paravertebral muscle mass underlying 1 AbPT and 2 NT sites (1 segment above and below the AbPT site) in the thoracic PVG regions. Electromyographic activity was recorded under the following conditions: resting prone, prone active trunk extension, application of pressure (300 kPa) to adjacent spinous processes, resting seated, passive and active seated trunk rotation, and supporting 2-kg weights in outstretched arms.

Results: Mean EMG activity was highest at the AbPT site, relative to NT sites, under all conditions, with a significant between-group effect of site ($F_{2,31} = 4.13$, $P = .03$) and large between-group effect size ($\eta^2 = 0.21$). There was also a trend for lower percentage change from baseline resting at the AbPT sites, relative to the NT sites, in response to the demand of other conditions. There were large variations in EMG activity within and between individuals, and large SDs accompanied the mean values of EMG activity in all cases.

Conclusion: Increased motor activity may be a contributing factor to tissue changes in the PVG detected with palpation. However, caution must be used when interpreting these results because of the large variations, small sample size, and issues associated with EMG normalization. (J Manipulative Physiol Ther 2006;29:437-447)

Key Indexing Terms: *Muscle; Skeletal; Spine; Electromyography; Palpation; Osteopathic medicine; Chiropractic*

Authors in manual therapy have claimed that abnormal or irregular tissue texture detected by manual palpation is commonly associated with somatic dysfunction, a functional disturbance of the musculoskeletal system.[1-8] Furthermore, some authors have proposed that altered tissue texture in the paravertebral gutter (PVG) region, the longitudinal groove, which lies between the vertebral spinous processes and the bulk of the erector spinae muscle group, is a specific diagnostic feature of intervertebral somatic dysfunction. Irregularity of segmental tissue texture may include abnormal hardness, bogginess, or ropiness of the deep paraspinal tissues.[1-3,8] Greenman[3] claimed that tissue change in the PVG is usually found unilaterally and reported as being tender by the patient.

Fryer et al[9] have confirmed that sites in the thoracic PVG detected primarily by deep palpation of abnormal tissue texture, with a secondary confirmation of tenderness by the subject, were significantly ($P < .01$) more sensitive to pressure than adjacent, normal and nontender (NT) sites.[3] In a follow-up study, Fryer et al[10] examined the possibility that tissue texture irregularity of sites located in the PVG was due to differences in underlying muscle thickness. The anteroposterior cross-sectional dimension (thickness) of the paraspinal muscle bulk directly underlying each marked location was measured using diagnostic ultrasound, and normal and abnormal to palpation (AbPT) regions were found to have similar mean dimensions. This study suggested that factors other than paraspinal muscle thickness were likely to account for abnormal tissue texture in the thoracic PVG regions of young, largely asymptomatic adults.

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Authors of manual therapy texts have claimed that hypertonicity of the deep paraspinal muscles, particularly rotatores and multifidus, is responsible for paraspinal tissue irregularity associated with intervertebral dysfunction.[1,2,8] Osteopathic researchers, Denslow and Korr et al,[11-15] conducted studies that they claimed provided evidence of increased segmental muscle activity and sympathetic nervous system output at spinal levels associated with clinically detected segmental dysfunctions. Denslow and Clough[11] examined the electromyographic (EMG) activity of the paraspinal muscles in 16 healthy subjects using needle electrodes and reported that spontaneous electrical activity occurred at "lesioned segments" detected with palpation but rarely at normal segments. In later studies, Denslow et al[13,14] reported that when pressure was applied to spinous processes, reflex paraspinal activity occurred at lower pressures on segments detected as abnormal with palpation than adjacent, normal segments.

The studies of Denslow and Korr, however, are older 50 years and were, by today's standards, poorly described with insufficient data reported and without statistical analysis. Slosberg[16] suggested that the diameter of the needles used by Denslow was larger than the fine-wire needle electrodes used today, which could have caused additional tissue disruption. Reproduction of these studies with modern equipment would help validate their findings.

The proposals of "muscle spasm" and "pain-spasm-pain cycle" are popular explanations for hard and tender muscles, but the evidence to support these concepts is lacking.[17] Fryer et al[18,19] reviewed the topic of paraspinal muscle dysfunction associated with intervertebral dysfunction and found there was little direct evidence for muscle hyperactivity as a cause of abnormal tissue texture. Johansson and Sojka[20] proposed that muscle pain and inflammation may increase fusimotor (muscle spindle) reflexes, which would not result in changes to resting EMG activity but may increase the activity in response to passive or active stretching, such as during passive spinal motion testing. There is experimental evidence of increased stretch reflexes in animals,[21,22] but researchers have failed to find evidence of it in subjects with low back pain.[23,24]

Because of the shortcomings of studies conducted by Denslow et al[11-14] and the low level of evidence to support the popular notion of muscle spasm as a cause of tissue texture abnormality, there is a need to reinvestigate the EMG activity of paraspinal muscles underlying sites detected as AbPT, using modern techniques. Fine-wire electrodes record EMG activity from a small region of muscle and are commonly used for recording activity from muscles that are small or deep, or from single muscle fibers.[25] Surface electrodes do not accurately record the EMG activity of deep paraspinal muscles, such as the multifidus and rotatores, because they are more sensitive to the superficial erector spinae group and are influenced by cross-talk.[26]

The present study examined the EMG activity of deep paraspinal muscles underlying sites in the thoracic PVG, using fine-wire EMG techniques to determine if increased activity of these muscles under various experimental conditions was associated with altered tissue texture and tenderness detected by palpation. It aimed to further investigate the reports of paraspinal muscle hyperexcitability associated with palpable abnormalities in paraspinal tissues and explore the effects of posture and passive and active movement on the activity of these muscles to determine if these muscles respond abnormally to passive stretching and functional demands.

Methods

Subjects

Twelve subjects (mean age, 25.42 years; SD, 5.81) were recruited from the student population at Victoria University, Melbourne. Six subjects were asymptomatic, whereas 6 presented with mild, self-reported thoracic pain and stiffness. All subjects had experienced mild thoracic symptoms (mild pain or stiffness) at some stage over the last 3 months. Individuals were excluded from the study if they were unable to lie prone for 30 minutes, had any medical condition that precluded them from fine-wire EMG testing, and if no AbPT site in the thoracic PVG could be found. The Victoria University Human Research Ethics Committee approved the procedures for this study, and all subjects signed a standard consent form and were free to withdraw at any time.

Measures and Instruments

Palpation

Examiner 1 (GF) palpated the medial paraspinal thoracic regions of each subject using the fingertips to identify 1 site that was AbPT and reported as tender by the subject (AbPT) and 2 NT sites, 1 segment immediately above (NT1) and below (NT2) the AbPT site. Previous studies[9,10] have determined that there will usually be 1 or 2 AbPT sites in the thoracic paraspinal region, even in asymptomatic subjects. Abnormal sites were identified primarily on the basis that they appeared to have abnormal tissue texture on deep palpation, and then a report of tenderness was requested from the subject. Only sites that appeared AbPT and were reported as being markedly tender were designated as AbPT. Using the same palpation procedure and examiner, a previous study established that these sites were significantly more sensitive to pressure, measured by a novel pressure algometer.[9] Each site was marked with 4 reference lines using a skin marker.

Electromyography

Examiner 2 (AB), a qualified physiotherapist with substantial experience in fine-wire EMG, performed the